Advantages of Caudal Anesthesia for Premie Hernia Repair: An Evidence- Based Debate

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The goal of anesthesia for the expremature infant having hernia repair is to provide a safe anesthetic that will minimize intra- and postoperative cardiorespiratory complications and have minimal long lasting effects on the developing infant. General (GA) and regional anesthesia, spinal anesthesia (SA) and caudal anesthesia (CA) are options well described in the anesthesia literature. The choice of anesthetic for these patients should be based on prospective safety, efficacy and economic data but is often based on a practitioner's passion toward a technique rather than scientific evidence. My practice is to use single dose CA, with SA in the event of a failed caudal block.

General anesthesia has been well demonstrated to increase the incidence of respiratory complications up to 54 and maybe even 60 weeks post conception. The risk appears to be as high as 5 per cent (95% statistical significance) until 48 weeks post conception with gestational age 35 weeks and up to 1 per cent (95% statistical significance) until 54 weeks post conception with gestational age 35 week. (Cote CJ Anesthesiology 1995. 82: 809-822).

A number of studies demonstrate regional anesthesia to been less likely to lead to perioperative apnea and bradycardia than GA. (Welborn L Anesthesiology 1990. 72:838-842; Krane EJ Anesth Analg 1995. 80: 7-13; Somri M Anaesthesia 1998. 53:762-766; Williams JM Br J Anaesth 2001. 86:366-371; Broadman LM Regional Anesthesia 1996 21(6S) 108-113). Yet, perioperative apnea occurs even with unsupplemented SA and CA. A recent Cochrane meta-analysis of 4 controlled trials comparing GA with SA demonstrated no benefit to SA anesthesia. However, if infants having preoperative sedatives were excluded there was a reduction in postoperative apnea in the SA group and a reduction of borderline significance in the use of postoperative assisted ventilation in the SA group. (Craven PD. Cochrane Database of Systemic Reviews 2005.Volume 4). There are several other reasons for general anesthesia to be a less appealing option. Regional anesthesia avoids the requirement for tracheal intubation and the potential for further airway trauma in infants that had been previously intubated and at risk for subglottic stenosis or cysts. Of yet unconfirmed significance is emerging data regarding general anesthesia-related development of accelerated apoptotic neurodegeneration in the developing brain (Jevtovic-Todorovic V. J Neuroscience 2003. 23:876-882. Yon JH Neuroscience 2005. 135: 815-27.)

Both CA and SA have been utilized safely in expremature infants and each has its advantages and disadvantages. Why do I prefer CA to SA as a first choice for regional anesthesia in the expremature infant? Advantages of CA include a longer duration of action than SA anesthesia, familiarity and more experience for the average practitioner (proficiency), and not requiring direct entry to the dural contents. Gunter demonstrated a 95% block success rate and an average time to complete block of less than 2 minutes in 20 high- risk infants having CA. Twenty-five percent of the infants required supplementation (N2O or ketamine), similar to SA studies. (Gunter JB J Pediatric Surgery 1991. 26: 9-1. Bouchut reported success without supplementation in 22/25 ex-premature infants having CA for hernia repair. (Bouchut JC Paediatric Anaesthesia 2001.11:55-58). In Veyckeman's report of 1100 CA in a teaching hospital, there was less than 2 per cent block failure in the 203 infants less than 5 kg. (Veyckemans F. Regional Anesthesia 1992 17:199-125),

The main advantage of CA to SA is the longer duration of caudal block as the addition of laparoscopic evaluation of the contralateral groin or a circumcision to hernia repair can extend the procedure to well over 60 min. The duration of anesthesia in Gunter's series was 89 +/- 8 min. in the infants receiving plain bupivacaine and 155 min. in the infant dosed with bupivacaine with epinephrine. In series of SA, duration of block ranged from 71 +/- 14 minutes in infants 41-52 week post conception (Harnik EV Anesthesiology 1986. 64: 95-99) to 128 +/-3 minutes block with tetracaine plus epinephrine in infants age one month to 12 months (Rice LJ Regional Anesthesia 1994. 19: 325-329). In the latter, duration of block was measured by the response to a lumbar level stimulus, not to surgical stimulus. Webster reported a duration of anesthesia of 70-210 minutes in 39 high risk infants receiving 0.5- 0.9 mg/kg tetracaine with epinephrine, however 12 of these required general anesthesia and only 59% were unsupplemented. (Webster AC Can J Anaesth 1991.38:281-6).

The likelihood of failed block in both the CA and SA studies is reduced with experience. As most pediatric anesthesia practitioners perform many more caudal blocks than spinals in infants, most practitioners become with CA, especially in teaching institutions (Veyckemans 1992). Under the right circumstances (single anesthesia practitioner, speedy surgeon) the success rate of SA can approach 100 per cent (Rice LJ 1998 Reg Anesthesia 19:325-329, Frumiento C Arch Surg 2000. 135:445-51). More frequently SA is hampered by a significant incidence of failed access to the subarachnoid space, bloody taps and blocks requiring supplementation. The rate of failed access to cerebrospinal fluid was 17 percent and bloody tap 46% in a study evaluating the ease of neonatal spinal tap with or without local anesthetic (Pinheiro JMB Pediatrics 1993 91:379-382). Williams demonstrated 20 percent traumatic taps and failure in 4/17 SA in ex-prematures (Williams JM Br J Anaesth 2001. 86:366-71)-. Schenkman reported a failure rate of 16 per cent and spinal fluid could not be obtained in 3/58 ex-premature infants (Schenkman Z Can J Anaesth 2002. 49: 262-269- 58). Frumiento (2000) claimed a 97 per cent success rate with SA but 79% of the infants required supplementation.

Since both CA and SA will have a defined failure rate, we need to be prepared to have a plan B other than sending the infant back to the nursery or home and trying again later. Desparmet warned of attempting CA after failed SA attempts as a there is the potential for total spinal anesthesia. (Desparmet JF. Anesth Analg 1990. 665-7). In the event of failed CA, one could proceed with SA.

I will admit that there are drawbacks to caudal block in addition to failed block. 1. The block sets up slower than SA (10-20 minutes vs. almost immediate). 2. There is not a simple way to assure at the time of the procedure that the block will be a success (such as obtaining CSF in SA). Nonetheless, the issue that the prime target of proponents of SA is the relatively high dose of local anesthetic that is required. A dose of up to 1ml/kg of 0.375% bupivacaine with epinephrine is routine. With these doses, plasma total bupivacaine levels should remain well below the toxic threshold. (Mazoit JX Anesthesiology 1988. 63: 387-391; Eyres RL Anesth Intensive Care 1983.11:20-22; Ecoffey C Anesthesiology 1985 63:447-448.) However there is the real concern that potentially toxic levels of unbound bupivacaine exist because alpha-1-acid glycoprotein levels are lower infants. (Booker PD Br J Anaesthesia 1996. 76:365-368). However there is reassuring data in several animal models that supports bupivacaine as less toxic to the infant heart than to the adult heart. (Badgwell JM Anesthesiology 1990. 73:297-303. Berman MF Anesth Analg 1994 79:350-356). Breschan warned of CNS toxicity with doses of bupivacaine greater than 2 mg/kg as decreased alertness and a decreased frequency of the EEG was demonstrated after CA using 3.1mg.kg bupivacaine. (Breschan C Anaesthesist 1998. 47:290-294). Even SA has been demonstrated to have potentially adverse CNS effects as spinal anesthesia can reduce cerebral blood flow in ex-premature infants. (Bonnet MP Anesth Analg 2004. 98:1280-83). Last, in SA is the small but finite risk of aseptic meningitis after subarachnoid block. (Easley RB Anesthesiology 1999. 91:305-307).

Since GA, SA, and CA each have inherent advantages and disadvantages, it is up to each individual practitioner to understand the data presented and decide what will work for them in their particular setting (Teaching institution vs. private practice, surgeon speed, patient selection, practitioner comfort).